

Large topographic rises on Venus have previously been classified as volcano-dominated, rift-dominated and corona-dominated [1]. These regions are thought to be underlain by mantle plumes, with the variations between them apparently not indicative of an evolutionary sequence [1]. The presence of coronae at these rises has previously been interpreted to indicate the break-up of a plume head, with small-scale upwellings responsible for the formation of coronae [1]. We have examined the geology of coronae at three corona-dominated rises on Venus: Themis Regio, Eastern Eistla Regio, and Central Eistla Regio [see also 2]. The diameters of the rises range from 1000-1650 km, with swell heights of 1.0-1.5 km [1]. We specifically test whether geologic setting, lithospheric thickness or plume characteristics are controlling the morphology of the coronae, and evaluate the plume break-up hypothesis.

At Themis Regio, eight major coronae have been mapped, along with several smaller ones. The eight coronae range in diameter from 275 to 675 km. The topography of the features has been classified following the scheme presented in Smrekar and Stofan [3]. Four of the features are plateaus, two have rims surrounding an interior high, one has a rim surrounding an interior raised above the surrounding terrain, and the other is a depression partially surrounded by a rim. Two of the features have outer rises surrounding deep troughs, and are sites proposed to be subduction trenches [4]. Most of the coronae in Themis Regio have extensive associated flow deposits. Flows range in morphology from sheet-like to digitate, and both embay and are cut by corona-related deformation.

Mapping of Themis Regio under the Planetary Geology Mapping Program has permitted the delineation of some stratigraphic relationships between coronae. Flows from Shiwanokia, the largest corona, overlie some flows from a corona to the north, centered at 38.5°S, 284°. Flows from this corona overlie deposits from a corona centered at 34.5°S, 284° and Tacoma Corona. Flows from a corona at 37°S, 293° overlie deposits from Tacoma, Tamiyo and Ukemochi Coronae; deposits from Ukemochi and Tamiyo have contradictory age relationships illustrating that formation of the two coronae overlapped in time. The great complexity of the coronae in this region and their abundant volcanic deposits suggest long histories. While some relationship between episodes of volcanism can be observed, determining when a corona began forming is not possible.

Four coronae are located on the topographic rise at Eastern Eistla Regio, with an older corona located to the south of the rise. Near the center of the topographic rise lies a volcanic feature with irregular topography [5]. All of the coronae at Eastern Eistla Regio have very similar morphology: raised rims surrounding an interior which is approximately at the same level as the surrounding terrain. All four have an interior topographic high with radiating fractures. At two of the coronae, features centered at 18.5°N, 37.5° and 12°N, 49.5°, the interior topographic high is greater than 200 km across. These interior structures resemble features interpreted as radiating dikes swarms [6]. All of the coronae have associated volcanic deposits. The stratigraphy of the coronae is described elsewhere in this volume by Fleming and Stofan [5]; as at Themis Regio, the stratigraphy of corona flows can be discerned in some places, but each corona is likely to have had a protracted history.

Central Eistla Regio has two large coronae (with diameters of 300 and 345 km), a volcanic shield, and a smaller corona (diameter 170 km). The region has been previously described by McGill [7]. McGill did not classify Sappho as a corona as it has abundant radiating volcanic flows. However, it does have a well-defined annulus of fractures, and many coronae have well-developed flow aprons [8, 9]. Therefore, we consider Sappho to be a corona. While large shields also have abundant radiating flows, they have distinctive summit characteristics and shapes that differ from coronae. Sappho has a raised rim and an interior depression that lie above the surrounding terrain. The other large corona, centered at 14°N, 10°, has a partial rim with very chaotic interior topography; the small corona at 8.3°N, 11.7° is a depression. Both Sappho and the corona at 14°N, 10° have a large degree of associated volcanism. Flows from the volcano in Central Eistla Regio, Anala Mons, overlie flows extending to the south of Sappho [7], but it is not clear which feature began forming first.

While each of the three areas studied is a corona-dominated rise, the coronae at each rise vary greatly in morphology. Central Eistla Regio and Themis Regio have multiple types of coronae; Eastern Eistla Regio has basically one type of corona. The morphology of the coronae in Eastern Eistla Regio is most consistent with upwelling in the presence of a depleted mantle layer [3]. The other topographic rise coronae are consistent with this, but do not necessitate it. The great variation in morphology and yet similar-

ity in gravity signature of the rises indicates that the rises are most likely still active [2].

We interpret the variations in corona morphology yet similarity in gravity signatures at these rises to indicate that all the rises are in the same state of evolution, with active plumes. The coronae do not appear to indicate break-up of the plume head. Rather, we interpret them to have been produced by periodic instabilities rising off the plume head. This process can vary from plume to plume. For example, at Eastern Eistla Regio, the instabilities appear to have arisen at about the same time, relatively early in the history of the rise, resulting in the current late-stage forms of the coronae there. At Themis and Central Eistla Regiones, the various forms of the coronae reflect later development of instabilities which have formed at differing times.

It has previously been suggested that coronae may form on thin lithosphere and large volcanoes on thick lithosphere [7, 10]. The fact that development of Idem-kuva Corona postdated Gula Mons formation as at Western Eistla Regio [11], and the uniformity of coronae in all three geologic settings [9] are interpreted to reflect that factors other than lithospheric thickness must influence the formation of coronae vs. large volcanoes. We suggest that the necessity of complex plume models to account for the morphology of coronae [3] indicates that a relatively long duration upwelling with a tail is necessary to form a corona. Large volcanoes may be produced by shorter duration, hot blobs.

References.

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